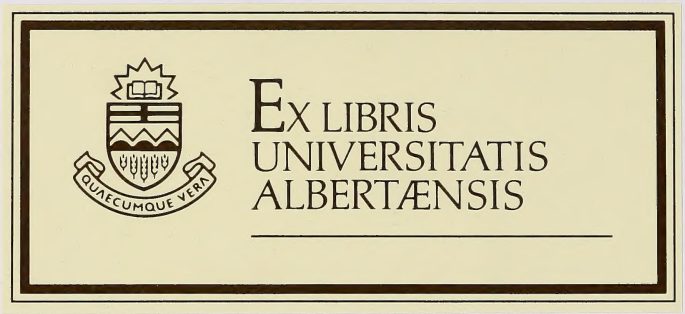
June 1995

Chemistry 30

Grade 12 Diploma Examination

Alberta
EDUCATION



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Chemistry 30

Grade 12 Diploma Examination

Description

Time: 2.5 h. You may take an additional 0.5 h to complete the examination.

Total possible marks: 80

This is a **closed-book** examination consisting of

- 44 multiple-choice and 12 numerical-response questions, each with a value of one mark
- 2 written-response questions, each worth 12 marks

This examination contains sets of related questions.

A set of questions may contain multiple-choice and/or numerical-response and/or written-response questions.

When required, a grey bar is used to indicate the end of a set.

A chemistry data booklet is provided for your reference.

The perforated pages at the back of this booklet may be torn out and used for your rough work. No marks will be given for work done on the tear-out pages.

Instructions

- Fill in the information required on the answer sheet and the examination booklet as directed by the presiding examiner.
- You are expected to provide your own scientific calculator.
- Use only an HB pencil for the machine-scored answer sheet.
- If you wish to change an answer, erase **all** traces of your first answer.
- Consider all numbers used in the examination to be the result of a measurement or observation.
- Do not fold the answer sheet.
- The presiding examiner will collect your answer sheet and examination booklet and send them to Alberta Education.
- Read each question carefully.
- Now turn this page and read the detailed instructions for answering machine-scored and written-response questions.

Multiple Choice

- Decide which of the choices **best** completes the statement or answers the question.
- Locate that question number on the separate answer sheet provided and fill in the circle that corresponds to your choice.

Example

This examination is for the subject of

A. chemistry
B. biology
C. physics
D. science

Answer Sheet

● Ⓑ Ⓒ Ⓓ

Numerical Response

- Record your answer on the answer sheet provided by writing it in the boxes and then filling in the corresponding circles.
- If an answer is a value between 0 and 1 (e.g., 0.25), then be sure to record the 0 before the decimal place.
- **Enter the first digit of your answer in the left-hand box and leave any unused boxes blank.**

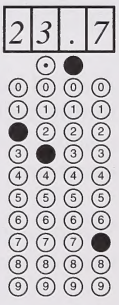
Examples

Calculation Question and Solution

The average of the values 21.0, 25.5, and 24.5 is _____.
(Record your answer to three digits on the answer sheet.)

Average = (21.0 + 25.5 + 24.5)/3
= 23.666
= 23.7 (rounded to three digits)

Record 23.7 on the answer sheet →



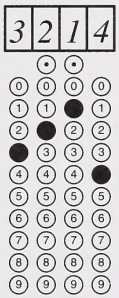
Correct-order Question and Solution

When the following subjects are arranged in alphabetical order, the order is _____. (Record all four digits on the answer sheet.)

1 physics
2 chemistry
3 biology
4 science

Answer 3214

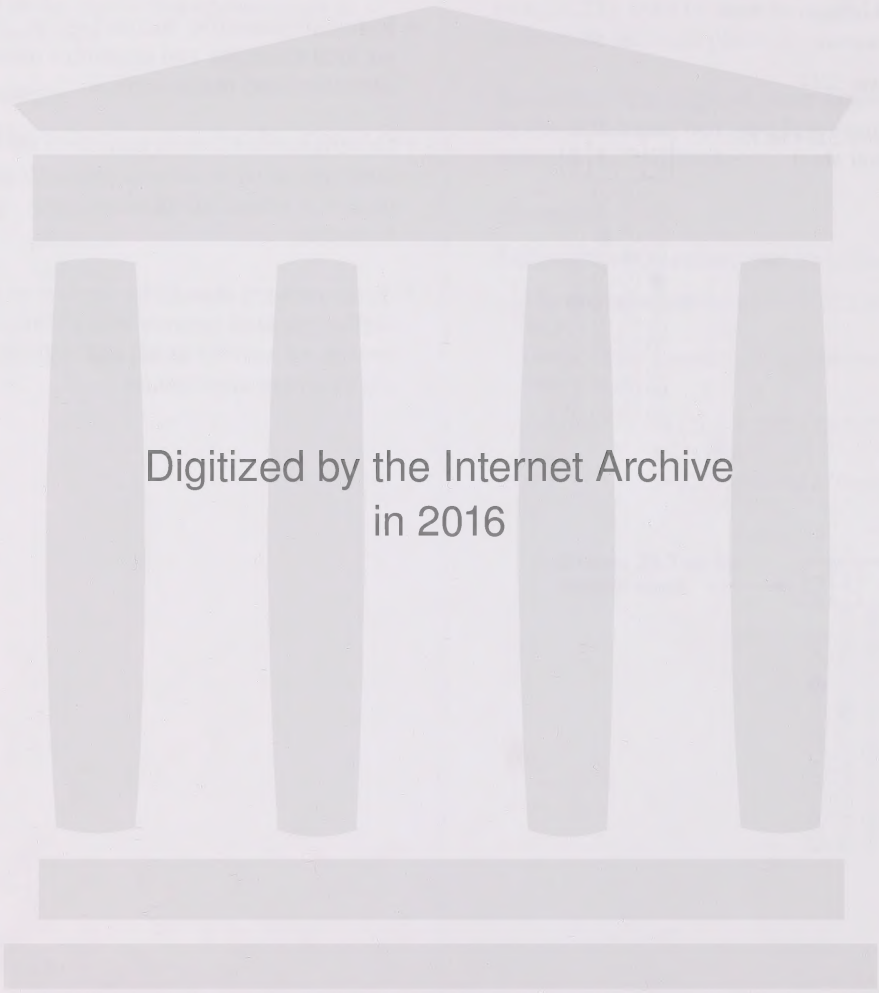
Record 3214 on the answer sheet →



Written Response

- Write your answers in the examination booklet as neatly as possible.
- For full marks, your answers must be well organized and address **all** the main points of the question.
- Relevant scientific, technological, and/or societal concepts and examples must be identified and made explicit.
- Description and/or explanations of concepts must be correct and reflect pertinent ideas, calculations, and formulas.
- Your answers **should be** presented in a well-organized manner using complete sentences, correct units, and significant digits where appropriate.

Do not turn the page to start the examination until told to do so by the presiding examiner.



Alberta has a plentiful supply of coal. Electric power generating stations in the Edmonton area burn coal as a source of energy. Coal can also be converted into other fuels. For example, water gas, a mixture of $CO_{(g)}$ and $H_{2(g)}$, is produced by passing steam over red-hot coal.

$$C_{(s)} + H_2O_{(g)} \rightarrow CO_{(g)} + H_{2(g)}$$

The water gas can then be converted to methanol, a proposed alternative fuel source.

$$CO_{(g)} + 2\,H_{2(g)} \rightarrow CH_3OH_{(l)}$$

1. The thermochemical equation that correctly represents the complete combustion of coal, $C_{(s)}$, is

A. $C_{(s)} + \frac{1}{2} O_{2(g)} + 110.5\text{ kJ} \rightarrow CO_{(g)}$

B. $C_{(s)} + \frac{1}{2} O_{2(g)} \rightarrow CO_{(g)} + 110.5\text{ kJ}$

C. $C_{(s)} + O_{2(g)} + 393.5\text{ kJ} \rightarrow CO_{2(g)}$

D. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} + 393.5\text{ kJ}$

2. If the heat produced by the combustion of coal is used to change water at 100°C to steam at 100°C,

A. the kinetic energy of the water increases

B. the potential energy of the water increases

C. both the potential and kinetic energy of the water increase

D. neither the potential nor kinetic energy of the water increase

3. In the production of methanol from water gas, the temperature of the surroundings will

A. decrease because the reaction is endothermic

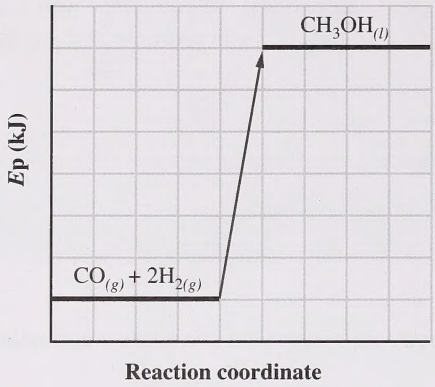
B. increase because the reaction is endothermic

C. decrease because the reaction is exothermic

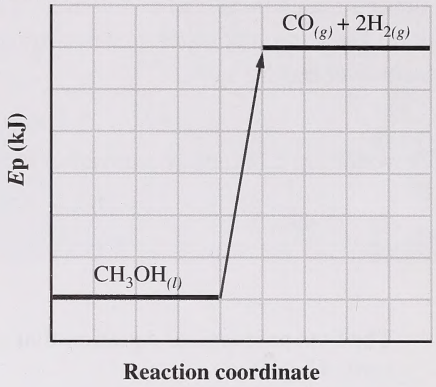
D. increase because the reaction is exothermic

4. The diagram that correctly represents the production of methanol from water gas is

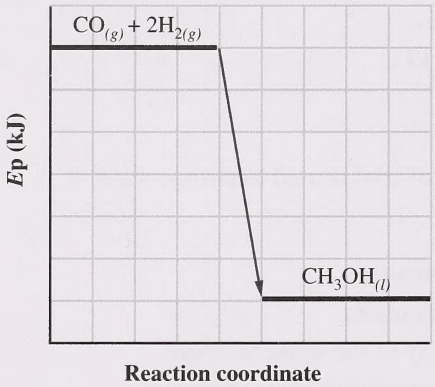
A.



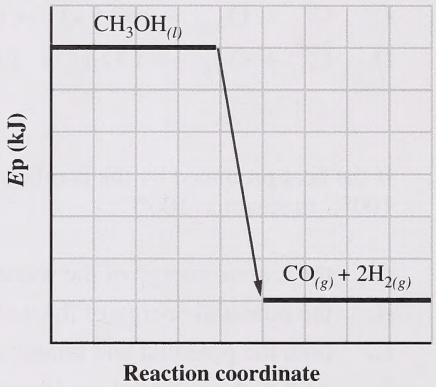
B.



C.



D.



5. The following table lists grades of coal and their composition.

Grade of Coal	Mass Percent of Each Element				
	C	H	O	N	S
lignite	71	4	23	1	1
subbituminous	77	5	16	1	1
bituminous	80	6	8	1	5
anthracite	92	3	2	1	1

The grade of coal that should provide the largest quantity of energy per kilogram burned is

A. lignite because of its high oxygen content
B. subbituminous because of its low nitrogen content
C. bituminous because of its high sulphur content
D. anthracite because of its high carbon content

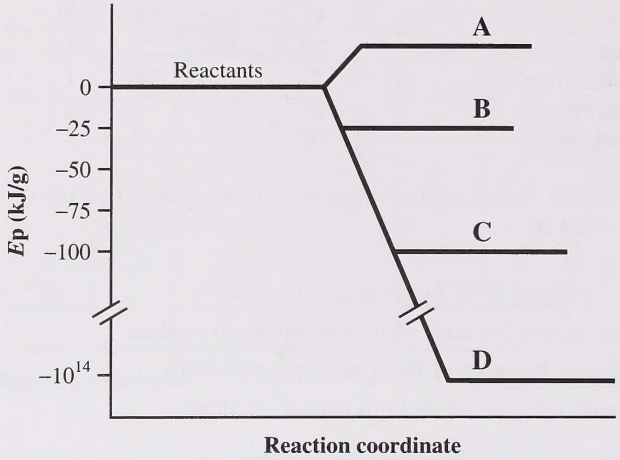
6. In Alberta, solar energy can be used as an alternative to natural gas for heating homes. One reason solar energy has not replaced natural gas for home heating is that

A. the amount of solar energy available depends on the weather
B. solar energy releases fewer pollutants into the atmosphere
C. solar energy is a renewable resource and natural gas is a non-renewable resource
D. solar energy is available at any site, but natural gas must be distributed by pipelines

7. A person drinks some apple juice that contains a variety of substances. In the body, the cellular respiration reaction that occurs is

A. $C_6H_{12}O_{6(aq)} + 6\ O_{2(g)} \rightarrow 6\ CO_{2(g)} + 6\ H_2O_{(l)}$
B. $C_{12}H_{22}O_{11(aq)} + 12\ O_{2(g)} \rightarrow 12\ CO_{2(g)} + 11\ H_2O_{(g)}$
C. $C_2H_5OH_{(l)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 3\ H_2O_{(g)}$
D. $CH_3COOH_{(aq)} + 2\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 2\ H_2O_{(l)}$

8. Select the letter that represents the potential energy of the products of a nuclear reaction.



Numerical Response

1. Use the following key to identify the type of bonding involved in each of the changes below.

Key	
1	intramolecular
2	intermolecular
3	intranuclear

The burning of methane:
$CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(s)}$ _____ (Record in column 1)

The corrosion of iron:
$4\ Fe_{(s)} + 6\ H_2O_{(l)} + 3\ O_{2(g)} \rightarrow 4\ Fe(OH)_{3(s)}$ _____ (Record in column 2)

The sublimation of dry ice:
$CO_{2(s)} \rightarrow CO_{2(g)}$ _____ (Record in column 3)

The decay of Uranium 238:
$^{238}_{92}U \rightarrow {}^{234}_{90}Th + {}^{4}_{2}He$ _____ (Record in column 4)

9. To protect an underground iron gasoline storage tank, a sacrificial anode of magnesium is attached to the tank. Which statement below explains how this attachment prevents the iron tank from corroding?

A. The magnesium loses electrons and is oxidized.
B. The magnesium gains electrons and is oxidized.
C. The magnesium loses electrons and is reduced.
D. The magnesium gains electrons and is released.

Use the following information to answer the next two questions.

During photosynthesis, plants take in carbon dioxide and, through a series of reactions, produce glucose.

10. In the overall reaction, carbon undergoes

A. oxidation
B. reduction
C. a gain in protons
D. a loss of electrons

11. Select the **false** statement concerning photosynthesis.

A. Hydrogen is oxidized.
B. Water is a necessary reactant.
C. The reaction is endothermic.
D. Carbon dioxide is removed from the environment.

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12. How many moles of $Ni_{(s)}$ are required to react with 3.57 mol of acidified $Cr_2O_7^{2-}{}_{(aq)}$?

A. 21.4 mol
B. 10.7 mol
C. 5.35 mol
D. 2.71 mol

13. Chlorine dioxide is used as a bleaching agent in the manufacture of paper. It is produced by the reduction of sodium chlorate solution with concentrated hydrochloric acid solution. The correctly balanced net ionic equation for this reaction is

A. $2\,NaClO_{(aq)} + 4\,HCl_{(aq)} \rightarrow 2\,Na_{(s)} + 2\,H_2O_{(l)} + 3\,Cl_{2(aq)}$
B. $ClO_3^-{}_{(aq)} + H_3O^+{}_{(aq)} \rightarrow HClO_{3(aq)} + H_2O_{(l)}$
C. $2\,ClO_3^-{}_{(aq)} + 2\,Cl^-{}_{(aq)} + 4\,H^+{}_{(aq)} \rightarrow 2\,ClO_{2(aq)} + Cl_{2(aq)} + 2\,H_2O_{(l)}$
D. $2\,ClO_3^-{}_{(aq)} + 6\,Cl^-{}_{(aq)} \rightarrow 3\,ClO_{2(aq)} + Cl_{2(aq)}$

14. According to the Standard Electrode Potential Table, the standard reference half-cell is

A. $F_{2(g)} + 2\,e^- \rightarrow 2\,F^-{}_{(aq)}$
B. $Ag^+{}_{(aq)} + e^- \rightarrow Ag_{(s)}$
C. $2\,H^+{}_{(aq)} + 2\,e^- \rightarrow H_{2(g)}$
D. $Fe^{2+}{}_{(aq)} + 2\,e^- \rightarrow Fe_{(s)}$

Use the following information to answer the next question.

$$X_{(?)} + I_{2(aq)} \rightarrow X^{2+}{}_{(aq)} + 2\,I^-{}_{(aq)} \qquad V = +0.94V$$

15. Substance $X_{(?)}$ is

A. $Cr_{(s)}$
B. $H_2Se_{(aq)}$
C. $Cu_{(s)}$
D. $Cd_{(s)}$

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16. Laboratory wastes must be carefully collected and stored for proper disposal. Which of the following materials would be suitable as a container in which to store an aqueous solution of nickel(II) nitrate?

A. Aluminum
B. Chromium
C. Tin
D. Zinc

17. A Chemistry 30 student placed a strip of cobalt metal into 1.00 mol/L $HCl_{(aq)}$ solution and correctly recorded several observations. Which observation would **not** appear in the student's notebook?

A. There was a spontaneous reaction.
B. The solution changed colour.
C. Bubbles of gas were produced.
D. A bleach-like odour was produced.

Use the following information to answer the next two questions.

Experimental Design: Metals and solutions of their ions are tested for evidence of reaction.

Observations:

	$Np_{(s)}$	$Mn_{(s)}$	$Os_{(s)}$	$Ac_{(s)}$
$Np^{3+}_{(aq)}$	–	×	×	√
$Mn^{2+}_{(aq)}$	√	–	×	√
$Os^{2+}_{(aq)}$	√	√	–	√
$Ac^{2+}_{(aq)}$	×	×	×	–

√ denotes a reaction
× denotes no reaction
– denotes not tested

Key:

1	$Np_{(s)}$	**5**	$Np^{3+}_{(aq)}$
2	$Mn_{(s)}$	**6**	$Mn^{2+}_{(aq)}$
3	$Os_{(s)}$	**7**	$Os^{2+}_{(aq)}$
4	$Ac_{(s)}$	**8**	$Ac^{2+}_{(aq)}$

Numerical Response

2. With reference to the key, list the four reducing agents in any order. _____
(Record your answer on the answer sheet.)

Numerical Response

3. With reference to the key, arrange the four oxidizing agents in order of **decreasing strength**. _____ (Record your answer on the answer sheet.)

Use the following information to answer the next two questions.

A solution of 0.0450 mol/L $Sn(NO_3)_{2(aq)}$ completely reacts with 25.0 mL of 0.100 mol/L $CrSO_{4(aq)}$.

Numerical Response

4. The volume of $Sn(NO_3)_{2(aq)}$ required is _____ mL.
(Record your answer to three digits on the answer sheet.)

Numerical Response

5. With reference to the key, arrange the four oxidizing agents from strongest to weakest.

Key	
1	$Cr^{2+}_{(aq)}$
2	$Sn^{2+}_{(aq)}$
3	$Cr^{3+}_{(aq)}$
4	$Sn^{4+}_{(aq)}$

(Record your answer on the answer sheet.)

---

18. In an electrolytic cell,

A. cations move to the anode
B. anions move to the cathode
C. cations move to the cathode
D. anions move through the wire

19. When a 7.3 g sample of bronze was analyzed by electrolysis, it was found to contain 5.00% zinc by mass. If the electrolysis took 30.0 min, the current used was

A. 0.15 A
B. 0.60 A
C. 8.2 A
D. 36 A

Titration, a laboratory procedure used to determine solution concentration, is used by industry as a means of quality control. For example, in a redox titration, 13.24 mL of 0.700 mol/L $K_2Cr_2O_{7(aq)}$ was used to oxidize a 10.00 mL sample of acidified $Sn^{2+}_{(aq)}$.

Numerical Response

6. The concentration of $Sn^{2+}_{(aq)}$ in the solution was _____ mol/L. (Record your answer to three digits on the answer sheet.)

20. The correct reduction half-reaction that occurs in the titration, with its appropriate electrical potential, is

A. $Sn^{2+}_{(aq)} + 2\,e^- \rightarrow Sn_{(s)}$ $V° = -0.14$ V

B. $Sn^{2+}_{(aq)} \rightarrow Sn^{4+}_{(aq)} + 2\,e^-$ $V° = -0.15$ V

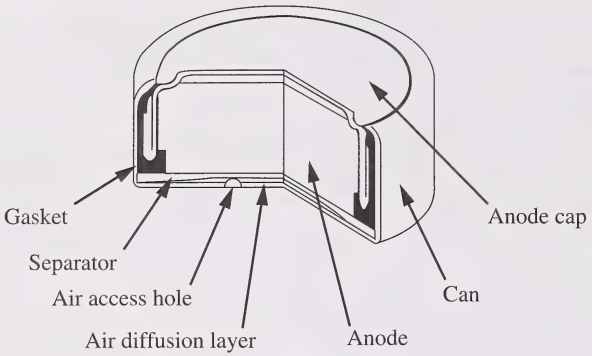
C. $Sn_{(s)} \rightarrow Sn^{2+}_{(aq)} + 2\,e^-$ $V° = +0.14$ V

D. $Cr_2O_7^{2-}{}_{(aq)} + 14\,H^+_{(aq)} + 6\,e^- \rightarrow 2\,Cr^{3+}_{(aq)} + 7\,H_2O_{(l)}$ $V° = +1.33$ V

Numerical Response

7. The net cell potential, under standard conditions, for the reaction is _____ V. (Record your answer to three digits on the answer sheet.)

Redox reactions play very important roles in providing society with highly portable energy devices such as zinc air batteries. Zinc air batteries, designed by Eveready™, are used primarily in hearing aids. A cutaway diagram of a zinc air battery is illustrated below, along with a listing of some of the battery's features.



Cathodes are catalyzed carbon that reduce oxygen from the air in the presence of water.
Anodes are a gelled mixture of amalgamated zinc powder and electrolyte.
Electrolyte is a highly conductive solution of KOH in water.
Separators are materials specially selected to prevent migration of solid particles between the electrodes.
Insulating and sealing gaskets are made of moulded nylon.
Exterior battery surfaces of nickel are used to resist corrosion and to ensure good electrical contact.

21. The separators in the zinc air battery act as

A. a porous barrier
B. an external circuit
C. a solvent in which the electrolyte is dissolved
D. a container to hold the contents of the battery

22. The half-reaction that occurs at the cathode of this cell is

A. $Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2\,e^-$
B. $O_{2(g)} + 4\,e^- \rightarrow 2\,O^{2-}_{(aq)}$
C. $O_{2(g)} + 2\,H_2O_{(l)} + 4\,e^- \rightarrow 4\,OH^-_{(aq)}$
D. $Zn_{(s)} + 2\,OH^-_{(aq)} \rightarrow ZnO_{(s)} + H_2O_{(l)} + 2\,e^-$

23. The electrical potential for this cell is 1.30 V. The reduction potential for the half-reaction that occurs at the anode of this cell is

A. –0.40 V
B. –0.54 V
C. –0.76 V
D. –0.90 V

24. The function of the air access hole is to

A. prevent the buildup of gases
B. allow the reducing agent to enter
C. allow the oxidizing agent to enter
D. prevent the formation of a vacuum

Citric acid, symbolized $H_3Ct_{(aq)}$, is a triprotic acid that fulfills a variety of roles. It is used as a food preservative as well as a flavouring agent for foods, beverages, and confections. It is also used to condition water, remove sulphur dioxide from smelter waste, and polish metals such as stainless steel. In addition, citric acid is a very important vitamin in the human body.

Citric acid dissociates through this series of steps:

$$H_3Ct_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + H_2Ct^-_{(aq)}$$
$$H_2Ct^-_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + HCt^{2-}_{(aq)}$$
$$HCt^{2-}_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Ct^{3-}_{(aq)}$$

25. The K_a values for the three steps in the dissociation, in random order, are

I. 7.0×10^{-4}
II. 6.5×10^{-6}
III. 1.8×10^{-5}

The K_a values for $H_3Ct_{(aq)}$, $H_2Ct^-_{(aq)}$, and $HCt^{2-}_{(aq)}$ respectively are numbered

A. I, II, III
B. I, III, II
C. II, I, III
D. II, III, I

26. Examples of two conjugate acid-base pairs are

A. $H_3Ct_{(aq)}$ and $H_2O_{(l)}$, $H_2Ct^-_{(aq)}$ and $H_3O^+_{(aq)}$
B. $H_2Ct^-_{(aq)}$ and $H_3O^+_{(aq)}$, $HCt^{2-}_{(aq)}$ and $H_2O_{(l)}$
C. $H_3Ct_{(aq)}$ and $HCt^{2-}_{(aq)}$, $H_3O^+_{(aq)}$ and $H_2O_{(l)}$
D. $HCt^{2-}_{(aq)}$ and $Ct^{3-}_{(aq)}$, $H_3O^+_{(aq)}$ and $H_2O_{(l)}$

27. The species that is amphiprotic is

A. $H_3Ct_{(aq)}$
B. $H_3O^+_{(aq)}$
C. $H_2Ct^-_{(aq)}$
D. $Ct^{3-}_{(aq)}$

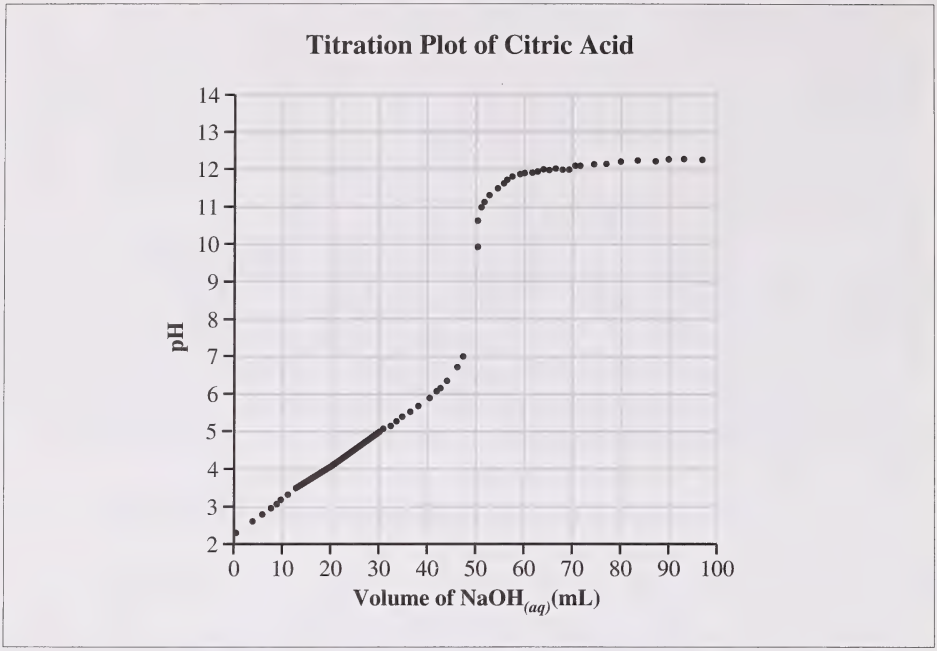
28. When citric acid is used as a flavouring agent, it tastes

A. sour
B. salty
C. sweet
D. bitter

29. The K_a for citric acid **cannot** be used to

A. calculate the equilibrium concentrations of the species involved, given the initial concentrations
B. decide if a given set of concentrations represents an equilibrium condition
C. predict the direction or extent of a reaction
D. determine the rate of a chemical reaction

Use the following information to answer the next three questions.



30. A 25.0 mL sample of citric acid is titrated to the **final** equivalence-point with 0.100 mol/L sodium hydroxide solution in the presence of a phenolphthalein indicator. Which of the following statements is correct?

A. The end-point is reached when the concentration of the acid equals the concentration of the base.

B. The end-point is reached when the concentration of $HPh_{(aq)}$ approximately equals the concentration of $Ph^-_{(aq)}$.

C. The equivalence-point is reached when the volume of base equals the volume of acid.

D. The equivalence-point is reached when the pH is equal to 7.00.

Numerical Response

8. The concentration of citric acid used in this titration is determined to be _____ mmol/L. (Record your answer to three digits on the answer sheet.)

31. If phenolphthalein had not been available for this titration, what other indicator could have been used?

A. Thymol blue
B. Litmus
C. Indigo carmine
D. 1,3,5–trinitrobenzene

Use the following information to answer the next question.

$$N_{2(g)} + O_{2(g)} + 180.4\ kJ \rightleftharpoons 2\ NO_{(g)}$$

32. In order to reduce the amount of nitrogen oxide pollutants in the air resulting from the combustion of fossil fuels, a design engineer would like to shift the equilibrium to the left. This could be accomplished by

A. a decrease in temperature
B. the addition of a catalyst to the fuel
C. an increase in the concentration of $O_{2(g)}$ in the combustion mixture
D. increasing the pressure by decreasing volume

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33. Equal volumes of an acid and a base solution are mixed. The resulting solution has properties that are not characteristic of either an acidic or a basic solution. This occurs because

A. a strong acid and a weak base were mixed
B. a weak acid and a strong base were mixed
C. a single replacement reaction occurred and hydrogen gas was produced
D. the acid and base contained equivalent amounts of $H_3O^+_{(aq)}$ and $OH^-_{(aq)}$

34. A Chemistry 30 student poured two unlabelled solutions together while cleaning the lab. The poisonous gas $H_2S_{(g)}$ was produced as a result of the mixing. A forensic scientist investigating the resulting accidental student death concluded that the two solutions were

A. $Na_2HBO_{3(aq)} + Na_2S_{(aq)}$
B. $Na_2SO_{3(aq)} + HCl_{(aq)}$
C. $NaOH_{(aq)} + Na_2S_{(aq)}$
D. $Na_2S_{(aq)} + HCl_{(aq)}$

Use the following information to answer the next question.

1	$CH_3COOH_{(aq)}$	**5**	$NaHCO_{3(aq)}$
2	$HCN_{(aq)}$	**6**	$NaOH_{(aq)}$
3	$H_2SO_{3(aq)}$	**7**	$Na_2O_{(aq)}$
4	$H_3BO_{3(aq)}$	**8**	$NH_{3(aq)}$

Numerical Response

9. Arrange the acidic solutions from strongest to weakest. _____
(Record your answer on the answer sheet.)

Use the following information to answer the next two questions.

Acid-base reactions are critical to maintaining equilibrium within the human body. A constant pH is maintained by the $H_2PO_4^-{}_{(aq)}$ / $HPO_4^{2-}{}_{(aq)}$ buffer system.

35. The most likely reaction between this buffer system and a solution containing the carbonate ion is

A. $CO_3^{2-}{}_{(aq)} + H_3PO_{4(aq)} \rightleftharpoons H_2PO_4^-{}_{(aq)} + HCO_3^-{}_{(aq)}$
B. $CO_3^{2-}{}_{(aq)} + HPO_4^{2-}{}_{(aq)} \rightleftharpoons PO_4^{3-}{}_{(aq)} + HCO_3^-{}_{(aq)}$
C. $CO_3^{2-}{}_{(aq)} + H_2PO_4^-{}_{(aq)} \rightleftharpoons HCO_3^-{}_{(aq)} + HPO_4^{2-}{}_{(aq)}$
D. $HCO_3^-{}_{(aq)} + H_2PO_4^-{}_{(aq)} \rightleftharpoons H_2CO_{3(aq)} + HPO_4^{2-}{}_{(aq)}$

36. The **true** statement about the reaction between carbonate ions and the buffer system is that equilibrium favours

A. products because $HCO_3^-{}_{(aq)}$ is a weaker acid than $H_2PO_4^-{}_{(aq)}$
B. products because $H_2PO_4^-{}_{(aq)}$ is a weaker acid than $HCO_3^-{}_{(aq)}$
C. reactants because $HCO_3^-{}_{(aq)}$ is a weaker acid than $H_2PO_4^-{}_{(aq)}$
D. reactants because $H_2PO_4^-{}_{(aq)}$ is a stronger acid than $CO_3^{2-}{}_{(aq)}$

Municipal swimming pool water is treated with chlorine compounds that have the ability to kill harmful bacteria. To assure safe, appropriate levels of these chlorine compounds, a pH range of 7.2 to 7.8 is essential. Within this pH range, the equilibrium $H_2O_{(l)} + HOCl_{(aq)} \rightleftharpoons H_3O^+_{(aq)} + OCl^-_{(aq)}$ maintains approximately equal concentration of $HOCl_{(aq)}$ and $OCl^-_{(aq)}$.

37. The K_a equilibrium expression for the reaction is

A. $K_a = \dfrac{[HOCl_{(aq)}]}{[H_3O^+_{(aq)}]\,[OCl^-_{(aq)}]}$

B. $K_a = \dfrac{[HOCl_{(aq)}]\,[H_2O_{(l)}]}{[H_3O^+_{(aq)}]\,[OCl^-_{(aq)}]}$

C. $K_a = \dfrac{[H_3O^+_{(aq)}]\,[OCl^-_{(aq)}]}{[HOCl_{(aq)}]}$

D. $K_a = \dfrac{[H_3O^+_{(aq)}]\,[OCl^-_{(aq)}]}{[HOCl_{(aq)}]\,[H_2O_{(l)}]}$

38. Samples of pool water were tested with several acid-base indicators. The results are given in the table.

Indicator	Colour
thymolphthalein	colourless
phenol red	red
litmus	blue/purple

The pH of this pool water is approximately

A. 6.6
B. 7.0
C. 8.7
D. 10.6

Numerical Response

10. The pH of a sample of 0.020 mol/L $HOCl_{(aq)}$ used in treating pool water is _____. (Record your answer to three digits on the answer sheet.)

Numerical Response

11. When equal concentrations of $OCl^-_{(aq)}$ and $HOCl_{(aq)}$ are present, the pH of swimming pool water is _____.
(Record your answer to three digits on the answer sheet.)

39. If pool water is warmed from 11.2°C to 25.1°C, the water molecules experience a change primarily in

A. nuclear energy
B. kinetic energy
C. potential energy
D. kinetic and potential energy

Numerical Response

12. Methane is burned to heat 134.6 Mg of water in a swimming pool from 11.2°C to 25.1°C. The amount of energy that must be absorbed by the water is _____ GJ.
(Note: 1 GJ = 10^9 J and "c" for pool water is the same as $H_2O_{(l)}$.)
(Record your answer to three digits on the answer sheet.)

40. The amount of energy available from the combustion of 1.00 mol of $CH_{4(g)}$ into gaseous products is

A. 710.1 kJ
B. 802.3 kJ
C. 877.7 kJ
D. 951.9 kJ

41. The combustion of methane is an example of an

A. endothermic reaction in which methane is reduced
B. endothermic reaction in which methane is oxidized
C. exothermic reaction in which methane is reduced
D. exothermic reaction in which methane is oxidized

Use the following information to answer the next three questions.

Hypochlorous acid can be produced by carefully adding chlorine gas to pool water as shown by the equation.

$$Cl_{2(g)} + 2\,H_2O_{(l)} \rightarrow HOCl_{(aq)} + H_3O^+_{(aq)} + Cl^-_{(aq)}$$

42. The problem with producing $HOCl_{(aq)}$ in this way is that the pH of the pool water

A. decreases because hydronium ions are also produced
B. increases because hydronium ions are also produced
C. decreases because chloride ions are also produced
D. increases because chloride ions are also produced

43. The substance undergoing reduction in this reaction is

A. $Cl^-_{(aq)}$
B. $Cl_{2(g)}$
C. $H_2O_{(l)}$
D. $H_3O^+_{(aq)}$

44. The balanced half-reaction for the reduction that occurs is

A. $Cl_{2(g)} + 2\,e^- \rightarrow 2\,Cl^-_{(aq)}$
B. $2\,H_2O_{(l)} \rightarrow 4\,H^+_{(aq)} + O_{2(g)} + 4\,e^-$
C. $Cl_{2(g)} + H_2O_{(l)} + 2\,e^- \rightarrow OCl^-_{(aq)} + Cl^-_{(aq)}$
D. $Cl_{2(g)} + 2\,H_2O_{(l)} \rightarrow HOCl_{(aq)} + 2\,H^+_{(aq)} + 2\,e^-$

Written Response – 12 marks

1. Describe two different methods that could be used to distinguish between a strong acid and a weak acid of equal concentration. Explain clearly how each method identifies the acid as weak or strong.

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Use the following information and data to answer the next question.

Fireball Horror of Aerosol Can Blast

A housewife was engulfed in a fireball when she tried to separate two cans of hairspray that were taped together. She accidentally punctured one aerosol can with a knife as she cut the tape.

A jet of butane gas shot into her living room fireplace, ignited, then immediately exploded into a fireball that wrecked the room and enveloped the housewife in flames.

Melting point of butane	–138.0°C
Boiling point of butane	–1.0°C
Hairspray use of butane	solvent and propellant

Written Response – 12 marks

2. a. Write the balanced chemical equation for the reaction that occurred and calculate the molar heat of reaction. Assume gaseous products.

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b. Instead of butane, non-flammable substances such as chlorofluorocarbons (e.g., CF_2Cl_2) are sometimes used as solvents and propellants for aerosol products. However, chlorofluorocarbons have been linked to damage to the ozone layer in Earth's upper atmosphere. Select a position either for or against the continued use of butane as a propellant for aerosol cans. Justify each issue addressed in your argument.

You have now completed the examination.
If you have time, you may wish to check your answers.

No marks will be given for work done on this page.

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